Sta. Library

UNITED STATES DEPARTMENT OF AGRICULTURE

FOREST SERVICE

HOW TO JUDGE

SOUTHWESTERN RANGE CONDITIONS

U. S. Dept. of Agriculture
Library, Tucson Station
Southwestern Forest and Range
Experiment Station
Box 951
Tucson, Arizona

M—5123

U. S. GOVERNMENT PRINTING OFFICE: 1930

8—7417

U. S. DEPARTMENT OF AGRICULTURE
Forest Service

HOW TO JUDGE SOUTHWESTERN RANGE CONDITIONS

A Preliminary Guide for Forest Officers in the Southwestern District

By M. W. Talbot

Formerly, Grazing Examiner
In Charge of Grazing Studies
Southwestern District

Issued, 1924, Southwestern District, F. C. W. Pooler, District Forester
Reissued, slightly edited, 1935, California Forest and Range Experiment Station, E. I. Kotok, Director

LIBRARY COPY
ROCKY MTN. FOREST & RANGE
EXPERIMENT STATION

HOW TO JUDGE SOUTHWESTERN RANGE CONDITIONS

Contents

Page

The problem 1

Important factors to be taken into account by range judges 2
Past and present use 2
Vegetation and soil 2
Present stocking in relation to past stocking 2
Present handling compared to former handling 3
Kind of range 3
Departure from average seasonal growth of forage 3
Time of examination 4
Proper concept of grazing capacity 4
What is carrying capacity 4
The climatic basis for estimates of carrying capacity . . 5
Especial points to remember in estimating carrying capacity 5

Word pictures of degrees of utilization 7
Some definitions 7
Range indicators 8
What is excess feed 9
Brief examples of excess feed by types 9
Proper or satisfactory use -- how to recognize it 10
Important considerations 10
The forage type -- composition and palatability 10
Topography 11
Soil 11
Sacrifice of very palatable but scattered plants 11
Erosion 11
Balance between summer and winter feed 12
A safety margin 12
"Weak links" of ranges often finally determine satisfactoriness 12
Criteria of satisfactory range conditions by broad vegetation types 13
Short-grass ranges 13
Bunchgrass ranges 13
Height of grazed-off bunches 13
Percentage of flower stalks and total crop to leave 14
Browse and desert ranges 14

Disturbance indicators of deteriorating ranges 14
Signs of a deteriorating range 15
Weak vitality of principal forage plants . . . 15
Too-close grazing of main forage species . . . 15
Close grazing of secondary feeds growing in mixtures 15
Thinning grass sod and dead branches of shrubs 16
Replacement of climax or original types of plants by weeds or less desirable species . . 16
Erosion 16
Condition of stock 17
Damage to timber reproduction 17
Western yellow pine 17
Spruce and fir 18
Aspen 18
Juniper and pinon 18
Causes of range decline 18
Overgrazing 18
Roads, trails, railroad grades, and irrigation ditches 18
Cultivation 19
Drouth 19
Range-destroying rodents 19
Logging operations, especially skidways 19
Fire 19
Floods due to natural causes 19
Chemicals in the soil 19
Earmarks of past range abuse 20
Disappearance of formerly abundant forage plants . . 20
Suspicious abundance of certain plants 20
Serious erosion and denudation 21

How to get more uniform range judging into actual practice 21
Continued explanation and discussion by the Office of Grazing of practical range judging hints 21
Frequent comparisons with protected areas or fenced plots . . 22
Construction of more protected comparative areas 22
A working knowledge of important range plants 22
Recording of more definite observations 22

HOW TO JUDGE SOUTHWESTERN RANGE CONDITIONS

THE PROBLEM

The story of range use and abuse dating back a good many years is written on the range itself. This record occasionally is clear and almost unmistakable, but more often it is framed in characters -- like the clay tablets of the ancients -- dimly uncertain and in code. A few fragments of the "key" to this "code" have been found and search for more continues. The complete key perhaps may never be found and, until the piece-work of fragments is more complete, some portions of the story of the range may be misleading. This point has caused considerable concern both in the study of range indicators and in the safe transmittal to the field of available information on "yardsticks of use" in a form that will be both usable and least likely to be wrongly interpreted. Nevertheless the need for more uniformity is great, and in the following pages the attempt is made to iron out various differences of viewpoint and to summarize the high lights of this vital subject into a set of working principles which seem sound in the light of our present knowledge.

The objective of this report is threefold:

1. To give workable definitions for numerous range terms.

2. To picture various stages of range condition, showing how they may be recognized.

3. To list usable indicators and available yardsticks of utilization, and to discuss their safe use.

The main responsibilities of forest administrators are:

1. To grow timber.

2. To protect watersheds.

3. To provide for the wise and balanced use of all forest resources.

The native forage is one of the principal forest resources. Generally over Arizona and New Mexico grazing is such a big problem, interlocked so closely with timber production and watershed protection, that its importance must be clearly recognized.

The grazing problem in the Southwest is very complex. Grazing grounds range in elevation between 1,500 and 13,000 feet. There are areas with a very short grazing season, no longer than three months, and others of yearlong range. Great differences likewise prevail in topography, soil, and vegetation. Finally, there is the erratic southwestern climate which,

so far as precipitation is concerned, seems to rise and fall in irregular cycles of vastly different years. Naturally such a complex set of conditions has resulted in corresponding confusion in their appraisal and analysis.

Uniformity in handling range examinations has greatly improved in recent years; but with the steadily increasing demand for range over the entire region and the greater interest in progressive range management in general, still greater uniformity is a vital need on the part of forest officers and stockmen. Indefinite or inaccurate reports of grazing conditions still show either a confusion of definitions of terms, poor observation, or faulty analysis of actual conditions.

IMPORTANT FACTORS TO BE TAKEN INTO ACCOUNT BY RANGE JUDGES

Experienced range examiners give particular weight to a few outstanding points.

Past and Present Use

More accuracy in sizing up any range always follows a close study of its history. Anything that can be found out concerning the following points will be helpful.

Vegetation and soil

1. What the range "looked like" 15 -- or 40 -- years ago.

2. What changes have occurred in recent years in kind, vigor, or abundance of plants, in size of forage crop, in timber growth, and in erosion.

3. Whether the present vegetation is stable or still changing.

With reference to these points, the experience and remembrance of reliable old timers should be consulted freely. Much evidence concerning changes often may be obtained from burns; for example, charred juniper stumps can still be found on certain "brush ranges" which are not supporting a tree growth now. Comparisons with protected areas are almost essential. The securing of small areas for this purpose on every Ranger District should no longer be delayed. In 1950 someone will want to know how the range looked in 1923 and what changes have occurred since.

Present stocking in relation to past stocking

Permit records, opinions of forest officers, and any other source

of information should be consulted frequently and analyzed in the attempt to determine as accurately as possible, year by year into the past, both the numbers of stock and the actual periods of grazing.

Present handling compared to former handling

Puzzling questions relating to the "looks" of a range can often be explained when one learns of some radical change within the past few years, either in the class of stock or in their handling.

Kind of Range

For broad inspection purposes, ranges may conveniently be classified from a forage standpoint as follows:

1. Sod-grass or short-grass ranges. (Fig. 1.)
2. Meadows or "cienagas." (Fig. 5.)
3. Bunchgrass ranges. (Fig. 2.)
4. Brush (or browse) ranges. (Figs. 7 and 8.)
5. Desert ranges. (Fig. 4.)
6. Various mixtures. (Fig. 14.)

Likewise from a timber standpoint, the following subdivisions are commonly employed:

1. Alpine.
2. Spruce-fir.
3. Yellow pine.
4. Woodland (or juniper-pinon).
5. Treeless (or almost treeless) "parks" or plains.

Departure from Average Seasonal Growth of Forage

Because of the extreme variation in southwestern climate from year to year and the corresponding rise and fall in forage crop, it is necessary to base grazing-capacity estimates in general on an average year or on one slightly below average, as nearly as these can be determined. Particularly when working on an unfamiliar range, therefore, it is essential for the examiner to know whether the current season is much better than average, much poorer than average, or about average -- in rainfall, forage crop, and stock-water conditions. To ignore this point is to invite decided error.

Another important point: After a drouth, the first year of average rainfall may not produce an average forage crop. Weakened forage plants may not recover in one season.

Time of Examination

The general appearance of southwestern ranges varies greatly from year to year and often from month to month. The degree of variation depends upon the season, and upon the type of range (particularly its altitude); on the desert ranges in southern Arizona, for example, there is no similarity between the appearance in March and in July. (Figs. 12 and 13.) In any examination, then, two vital points should be watched:

1. The development of vegetation to be expected at that time of year.

   This entails a working knowledge of the stage of growth that the various kinds of forage plants usually attain on the date in question; also an approximate knowledge of the stages of growth to be expected during the remainder of the grazing season.

2. The portion of the grazing season remaining at the time of examination.

   The percentage of the crop of feed still ungrazed must be correlated with the portion of the grazing season still remaining. In arriving at this comparison of crop percentages, fenced exclosures or protected areas will be found of great assistance.

Proper Concept of Grazing Capacity

A clear and conservative viewpoint regarding grazing capacity -- or carrying capacity -- is an absolute prerequisite to proper judging of range conditions. Much of the confusion and lack of uniformity in the past has resulted from differences in definition.

What is carrying capacity

The average stockman either attempts always to have a little reserve feed, or else to graze it to the last blade of grass before his neighbor gets it -- depending on whether he is the occasional progressive grazier of a controlled range or competing under open-range conditions where the "grab first" policy has generally prevailed.

Carrying capacity has been variously defined as follows: What the range will carry under present methods of management -- what it will carry and still maintain a maximum forage production -- what stocking it will bear and leave a small margin for slow improvement -- what it will carry without causing a "die-off." Why not settle upon the definition of Jardine and Anderson which holds good for any range. It is: "The maximum number of stock which the unit will support each season over a period of years without

injury to the range or tree growth or watershed, or unwarranted interference with game and recreation."

Carrying capacity should not mean the largest number of animals that can be carried through without heavy loss. Excess palatable feed should not be present in sufficient abundance to comprise a bad fire menace. Attainment of the happy medium means eliminating, to a point consistent with practical management, both overgrazing and excessive waste of feed. It does not mean that the end of each grazing season should find the previous season's growth of forage entirely consumed, because uncertainties of southwestern climate, as well as practical difficulties in handling stock, do not permit of a nicety of adjustment sufficient to place precisely the correct number of animals on an area each season to use all the feed without overgrazing the area. Some old forage should remain on the ground at the end of the grazing season. This should be considered insurance rather than waste.

The climatic basis for estimates of carrying capacity

Stocking southwestern ranges on the basis of the worst drouth years is impracticable. Stocking on the basis of the best years is a suicidal policy. Ranges should be stocked on the basis of an average year, or one slightly below average. When the dry years come, numbers of stock should be reduced by close culling or -- if practicable -- supplemental feed should be provided or the grazing season shortened. Since there apparently is no such thing as a "normal year" in the Southwest, the use of this term is discouraged.

Especial points to remember in estimating carrying capacity

1. Get clear on definition.

2. Study past as well as present stocking and handling of the area.

   Watch carefully the effect of first attempts at proper stocking, remembering that after all one big test of proper carrying capacity is whether there is palatable feed on the ground at the end of the grazing season.

3. Give any available reconnaissance forage-acre estimates a good try-out.

   They are guides of value. As a general figure, use 10 forage acres per cow on a yearlong basis. (Allowances of 9, and even 8, forage acres per cow have been used in a few estimates for areas having unusually favorable conditions of forage growth, climate and topography; however, these low figures should not be used generally. In fact, in some cases an allowance of more than 10 forage acres is necessary to insure adequate protection to watersheds or timber reproduction.)

4. Do not base estimates solely on the total crop of edible forage.

   Remember that deductions (in an amount varying with each individual case) are almost always necessary to allow for one or more of the following unfavorable conditions:

   a. Rough topography
   b. Inadequate watering facilities
      Insufficient amount
      Uneven distribution
      Lack of permanency
   c. Poisonous plants
   d. Dense timber
   e. Young timber growth
   f. Poor distribution of stock

5. Remember that yearly percentage fluctuations in size of forage crop often range from 15 to 25 -- occasionally 100 or more, especially in annual forage types. (Figs. 12 and 13.)

6. In making estimates for overgrazed ranges, remember that they are overgrazed.

   Avoid the mistake of judging grazing by the results of overgrazing. In making recommendations for the betterment of conditions on depleted ranges, or on ranges showing serious injury to timber reproduction, especial stress should be laid on a careful analysis of all probable causes and a consideration of what is practicable to secure in the way of proper numbers of stock, a different or a shorter grazing season, improved handling methods, better distribution of stock (through water development, salting, riding, fencing), or a change in class of stock. In extreme cases, where all other remedies have failed, exclusion of grazing animals should be considered.

7. Remember that a working knowledge of feed values of various combinations of forage plants to different classes of stock, under practical management, is indispensible.

8. In preparing carrying-capacity tables or reports, note clearly the management basis for the estimates.

   State whether based on authorization numbers, permitted use, or actual use; whether in terms of yearlong season or for a shorter grazing season; whether based on existing water developments, salting methods and control, or on needed improvements still to be obtained.

9. Finally, hold all estimates to a sound forestry basis.

Academic arguments do little good when they attempt to settle whether carrying-capacity estimates in general should be based on browse alone, on grass alone, or what allowance should be made for annuals. More experiments are needed to settle such points. Besides, there is a deeper basis than browse or grass or trees: the soil, without which "sustained yield" and "maximum forage production" become empty phrases. Fifty years from now the Forest Service will be judged by the condition of the forest watersheds (and all forests are potential watersheds), not by the 1923 receipts from timber cut from the Blank Sale Area or from livestock grazed on Allotment X. This forestry basis should be clearly put to new men.

Remember the definition of carrying capacity. Remember that grazing must be so regulated as to afford adequate protection to watersheds and tree growth, and to keep the ranges as nearly as possible in a permanent state of maximum forage production. In cases of doubt, especially concerning possible injury to watersheds, the only safe basis to work from is not what the feed will carry but what the ground will carry.

WORD PICTURES OF DEGREES OF UTILIZATION

Some Definitions

An area is overgrazed when decided damage, due to grazing, occurs to plants or soil -- or both. (Figs. 23 and 24.) Overstocking prevails when the number of animals on any specific area cannot be maintained through the intended grazing period without resultant damage.

It is evident that the element of time must be clearly stated in applying these definitions. For example, an area may have been overgrazed in the past but be even lightly grazed when examined. An area may be overstocked but not overgrazed; on a yearlong range, if forage sufficient for only 100 cattle is produced and 150 are placed on the area with the intention of leaving them throughout the year, the area is overstocked although no damage to either range or stock may be apparent for a number of months. The above definitions should be closely adhered to because of the considerable confusion that has resulted in the past from using the two terms interchangeably.

The following definitions are not so rigid and represent more nearly the average usage of inspectors.

Where less than 10 percent of the forage on an area is eaten at the end of the grazing season, the area may be classed as "practically unused." The term "lightly grazed" is usually applied when less than 50 percent of the palatable herbage is taken during the grazing season; "moderately grazed" often refers to a similar use of 40 to 75 percent; and "satisfactory use" on southwestern ranges usually implies the grazing of 75 to 90 percent of the palatable herbage of the more important plants. (See later chapters

for detailed discussions of satisfactory use.) The phrase "dangerously grazed" is applied to any degree of utilization that, in the judgment of the inspector, is likely to result in damage.

These few terms can be employed to convey a fairly uniform meaning; but the common usage of such terms as "close", "fairly close", "very close", and "exceedingly close" (as applied to forage utilization) is vague and should be discouraged, except when supplemented with percentages.

It is still better to apply percentages to the two or three principal classes of vegetation. For example, simply say in describing the utilization of the Blank Allotment at the end of the grazing season:

> "Satisfactory: 60 percent pine bunch and 90 percent blue grama grazed; galleta uneaten."

The evident advantages of this method over the prevailing practice are:

1. More definite statements -- although still brief.

2. Clearer pictures of conditions conveyed to readers of the report.

3. A record of what the particular examiner considered "satisfactory" utilization.

In using any of the above terms one should clearly state whether they apply to past or present grazing conditions.

Range Indicators

Range inspections cannot always be handled by the most experienced men; consequently this paper is particularly concerned with the clues to range happenings that are used either consciously or intuitively by the most experienced men in reaching their decisions.

Anything that can be used as a guide to recognition of the real state of range affairs -- non-use, satisfactory use, abuse -- either in the past or at present, may be classed as an indicator. Such indicators naturally fall into several classes:

Vegetative
- Vigor of vegetation
- Size of forage crop
- Composition of forage crop

Physiographic
- Topography
- Soil

Oral

The recognition of indicators is very important, particularly in detecting the first stages of very gradual processes which may be trending toward range improvement or range depletion. After improvement -- or retrogression -- has reached an advanced stage, the condition is usually unmistakable and indicators are not needed.

It is difficult to separate the grazing or biological factors from natural or physical factors. This admission should not leave the impression, however, that the use of range indicators is attended by so much difficulty that they have no practical value. They are very valuable aids, but the fact must not be lost sight of that they often only indicate and may not specifically state.

Obvious, but nevertheless important, is the reminder that a range cannot be fairly judged unless a fair sample of it is seen. A "fair sample" of topography, vegetation, and use only rarely can be seen from the principal travel routes. The aim should be to see conditions distant from roads and trails as well as adjacent to them, farthest from watering places, and also nearby.

What is excess feed

Excess range or feed is that which is not being grazed but which it is feasible to utilize under practical handling, without damage. Unused feed is uneaten feed which may or may not be eaten later. Reports will be greatly clarified if these distinctions are accepted and used.

Clearly, then, excess feed always means some unused feed, but unused feed may not be excess feed.

Brief examples of excess feed by types

Plants of low palatability, such as tobosa-grass (Hilaria mutica) and various bunchgrasses, may occur in small percentages within a main type of grama which is better relished by livestock. In small amounts, such inferior plants will probably not be eaten and could not be utilized without grazing the more palatable species "to the ground." In such cases the unused patches of vegetation should not be considered excess. (Fig. 11.)

In a bunchgrass range in yellow-pine country, unused bunchgrass which experience of the region has shown cannot be grazed more closely without unwarranted injury to young pine growth is not excess feed. (Fig. 9.) Blocks of bunchgrass which can be safely utilized by better but altogether feasible control of stock are excess.

On "short-grass" ranges, 10 to 15 percent, and on "bunchgrass" ranges, 25 percent (see also p. 13) of each year's growth left ungrazed at the end of the grazing season is not excess feed.

On brush ranges, shrubs which seem to be "gaining on stock" and bid fair ultimately to "take the range" are not excess feed if the intensity of grazing necessary to hold them in check and down within the reach of grazing animals entails the decided thinning or wiping out of more palatable grasses or other forage plants, or an increase in soil washing. (Fig. 8.) This is usually just what happens if the attempt is made to graze brush ranges heavily enough to keep them from growing beyond the reach of grazing animals.

On desert ranges, the big waves of annuals or "six-weeks plants" may be considered excess if extra stock moved in during the short periods when the feed is best can be moved out as the abundant feed begins to wane. Locally, such management is feasible with sheep. Such flexibility in the handling of cattle is rare, and unless it is certain that the herds can be moved when this uncertain irregular crop begins to dry up it is not excess feed. (Figs. 12 and 13.)

It is necessary to know what portion of the year the allotment is to be used. Without this knowledge, areas unused in the autumn but reserved for winter grazing might be erroneously considered "excess."

Fire menace alone should not determine excess feed. The beneficial effect of grazing in reducing fire risk should be fully appreciated, but if grazing sufficiently close to eliminate the fire risk means decided damage to other portions of the range, the area should not be considered excess, since the risk of injury to the forest through possible fire is usually the lesser risk in Region 3.

Proper or satisfactory use -- how to recognize it

In general, a satisfactory condition of range is indicated by the following conditions:

1. Vigorous appearance and growth of forage.
2. Absence of accelerated soil washing.
3. Lack of extensive areas overrun by unpalatable plants.
4. Absence of serious injury to timber reproduction. (Fig. 14.)

Excellent evidence that a previously depleted range is improving includes:

1. Thickening of the stand of good forage.
2. Reclaiming of gullies by vegetation. (Fig. 30.)

Important considerations

1. The forage type -- composition and palatability -- Forage plants differ in their ability to retain vigor and productivity under heavy grazing. Fenced plots on the Coconino, after ten years' observation, show

definitely that when ranges are overgrazed continuously pine bunchgrass (Festuca arizonica) and mountain bunchgrass (Muhlenbergia montana) both disappear from the range before blue grama (Bouteloua gracilis); black sporobolus (Sporobolus interruptus) in turn is the most resistant of all.

Secondary forage plants little relished by stock sometimes are only slightly grazed when found intermingled in small percentages with good feeds like bluestem (Agropyron spp.), blue grama, or curly mesquite (Hilaria belangeri). Proper utilization under these conditions should be judged by a closeness of use approximating 85 to 90 percent of the herbage of the more palatable species; utilization of the less palatable plants should be disregarded.

2. Topography -- A degree of use that may be safe on level or undulating land usually becomes dangerous use in rolling country and destructive overgrazing on ranges of steep rough slopes. (Figs. 1, 3, and 4.)

3. Soil -- A closeness of use that would be safe on heavy compact rock-studded soils, for example, will usually be destructive on loose ashy soils. After soil washing once starts in deep clays or clay loams, gullies are apt to continue "eating back" long after the original causes of their beginning have been removed; but in such deep soils the erosion damage is not so permanent and far-reaching in effect as in thin veneers of soil overlying shallow bedrock. In the former case it may be possible to repair the damage, but under some conditions the cost may be prohibitive. (Figs. 25 and 26.)

4. Sacrifice of very palatable but scattered plants -- Certain plants are greatly relished -- much more so than the bulk of the feed. Where such plants occur scatteringly over the range, they will be severely "punished" and an inspection of the range condition should not be based on their appearance. If these plants comprise only 5 percent (or possibly 10 percent) of the vegetation on ranges which do not show deterioration, they usually must be sacrificed in order to obtain a satisfactory use of the remaining 90 or 95 percent of the vegetation, provided that overgrazing and gradual disappearance of the 5 to 10 percent do not result in soil washing.

5. Erosion -- It should be remembered that erosion may be roughly divided into two kinds.[1/] Natural erosion through the ages occasionally and locally has been active and very rapid, but in general is a very slow process which builds up more than it tears down. Man cannot entirely stop erosion, and this so-called normal erosion should be recognized as nothing to be alarmed about; all agricultural lands have been made by it.

Opposed to the above is the aggravated erosion which has been increasing in many parts of the Southwest for many years and which is directly the result in most cases of man's occupation of the country. In appraising range conditions, the absence of this destructive erosion (figs. 24 to 27)

1/ See also the Watershed Handbook.

should be one main yardstick to apply, since protection of watersheds must be one of the prime objects of forest administration. The opinion occasionally voiced, that erosion in a degree that is decidedly alarming on the watershed of an existing reclamation project may often be considered negligible on certain similar ranges outside the watershed of any irrigation reservoir, is both unsound and dangerous. "All ranges are potential watersheds," and the surface soil that is washing away is the basis of timber and forage production.

6. Balance between summer and winter feed -- Summer and winter ranges are rarely balanced. Efforts to utilize all available range, therefore, have resulted in much damage, especially where the winter range has been inadequate. The relative sufficiency of summer and winter range, and facilities for shifting stock from one to the other, should be carefully weighed.

7. A safety margin -- If a yearlong range is examined in October and the next year's new growth is not expected before July, three-fourths (roughly) of the current year's forage should remain uneaten at the time of examination. In contrast, on a high-altitude summer range also examined in October, 75 or 80 percent of the palatable herbage may be gone and the range still be judged in satisfactory condition (as far as percentage of the crop already grazed is concerned). The correct judging of the portion of the current year's crop already grazed -- or still remaining -- requires careful observation and the drawing upon all available experience and knowledge regarding the feed values of the important plants, and the dates of beginning and ending of growth and grazing. Comparisons with protected areas within the big grazing types (plant associations) being examined will be found decidedly helpful.

8. "Weak links" of ranges often finally determine satisfactoriness -- On most ranges, choice mountain meadows, areas of thin soils, south exposures heavily grazed during the winter, and drainage lines forming natural trailways of livestock between feed and water are always more heavily used than the remainder of the allotment. These "key" portions of the range must be carefully watched and, if necessary, the utilization of 75 percent or more of the allotment reduced in order more adequately to protect these heavily used "weak spots." A limited amount of this kind of damage is unpreventable. Small areas around watering places cannot usually be protected from overgrazing. When these areas extend out one-fourth to one-half miles from water, however, conditions are decidedly unsatisfactory. As rough guides, these overgrazed areas of livestock concentration should always fall below 5 percent, and in practically all cases below 3 percent, of the total area. If excessive damage of this sort results, better distribution of stock through improved handling (riding, salting, water or fenced control) or a reduction in numbers usually will be necessary. Sometimes all that is needed is a shorter grazing season, or a postponed one to prevent grazing too early in the spring; again, a change in class of stock, or resting portions of the range in turn (deferred grazing), may be effective remedies.

Criteria of satisfactory range conditions by broad vegetation types

1. Short-grass ranges -- Such ranges include plant associations dominated by blue grama or curly mesquite grass.

a. An average of about 15 percent[1/] of the available crop of palatable herbage left unused at the end of the grazing season, during slightly-below-average years.

b. Absence of dead tufts or thinning sod. Vigorous color, general appearance, and height growth. Absence of evident increasing of unpalatable plants. (Such plants may have gained a foothold during past overgrazing.)

c. Reclaiming of former raw gullies or arroyos by vegetation. (Fig. 32.)

d. Absence of formation of new gullies.

e. Absence of noticeable sheet erosion.

f. Absence of serious damage to young timber.

2. Bunchgrass ranges -- A utilization word picture of what is a satisfactorily used bunchgrass is very difficult to draw. Experienced range examiners find it much easier to point out actual areas where utilization seems satisfactory than to put on paper any set of guides for other men to follow. Close watching of two points will be found helpful, however.

a. Height of grazed-off bunches -- From the standpoint of vigor alone, various "short grasses" (which are not dependent upon seed for reproducing) can safely withstand a closer and more continuous use than can most bunchgrasses. In general, such kinds as mountain bunchgrass or pine bunchgrass cannot safely be grazed to less than six inches in height, and fragmentary evidence indicates that cropping this close if repeated year after year will thin them. Careful observations indicate that species of more rank growth, such as Thurber fescue (Festuca thurberi) cannot be grazed this closely with safety.

In any event, animals do not crop bunchgrasses to a uniform height, like a mowing machine would. Moreover, some grass tufts or bunches are preferred to others and often only a portion of each bunch is chewed off to any given height. Consequently, height alone cannot be depended upon.

1/ Two main reasons are: (1) to provide a little leeway for the drier years, and (2) to lighten somewhat the strain on areas subjected to the heaviest use.

b. Percentage of flower stalks and total crop to leave -- At least 25 percent of the flower stalks should be permitted to go to seed, and about 25 percent of the grass remain uneaten. This suggestion is an attempt to approach from another angle the question of satisfactory use of fairly pure bunchgrass ranges. On ranges on which livestock run throughout the grazing season, it means that grazing should be light enough to permit at least one-fourth of the grass stalks to mature seed. It is recognized that there are ranges grazed under a deferred system. Under these deferred conditions where all of the grass stalks might mature seed before any grazing began, this clue indicates that at least 25 percent[1/] of the season's growth of bunchgrass should remain uneaten at the end of the grazing season. There is, of course, the uncertainty of determining "25 percent of the flower stalks" or "25 percent of season's growth," and here again protected comparative plots will be found very useful.

The above percentages are not backed by adequate data. Such figures are influenced by many variable factors. More study is needed on this very practical point, and future investigations probably will revise these figures. They comprise, however, something tangible to start from; their field use should promote greater uniformity in appraisals.

These percentage guides directly concern only one factor: vegetation vigor. The other considerations of timber, topography, exposure, soil, erosion, etc., apply to bunchgrass ranges the same as any other range. In judging satisfactoriness of use of a bunchgrass range, especially, the practice or possibility of "resting" portions of the range in turn by some form of deferred and rotation grazing should be fully considered.

3. Browse and desert ranges -- Satisfactory conditions here may be indicated, among other criteria, by --

a. Brush not grazed down to stubby branches.
b. Grass and herbs not grazed to the point of disappearance.
c. Erosion not threatened or beginning.

If, after a careful study of proper class of stock and all practicable measures of progressive handling, it is found that the grass cannot be maintained and serious erosion prevented without the brush "getting away from the stock," let the brush grow out of reach.

Disturbance indicators of deteriorating ranges

When the word "indicators" is used in connection with range judging,

---

1/ This figure applies only to "fairly pure" bunchgrass ranges -- ranges where bunchgrasses predominate. This percentage will vary as forage composition varies, and may run as high as 40 or 50% (for the bunchgrasses) on areas where bunchgrasses and better forage plants occur in mixture.

it too often has been the practice to think at once of "indicators of overgrazing." This term is both erroneous and unfair unless restricted closely to its intended meaning. Range deterioration is not always started by grazing abuse. A number of other factors, operating in varying degree, have disturbed Nature's original balance. Each factor has its own weight. All combine to produce the final result. Overgrazing is admittedly one of the most important causes of range damage -- in many instances is the largest single factor -- but it is not the only factor and has not caused all of the injury to ranges and watersheds. For this reason the use of the term "disturbance indicators" is suggested for such indicators in general. There is no objection to the term "overgrazing indicators" in its true and restricted sense.

Signs of a deteriorating range

1. Weak vitality of principal forage plants -- Continued punishment from excessive grazing (or any detrimental influence) is first evidenced by such things as:

a. Pale "sickly" color of herbage.
b. Reduced height growth.
c. Reduced volume of crop.

These symptoms appearing over extensive areas might be called the first danger signals and usually precede more pronounced signs. There are three checks to the examiner's judgment as to what is "sickly color" or "reduced height growth." They are:

a. His own experience and knowledge: What a vigorous crop of the particular forage type should "look like."

b. Instruction on the range by a more experienced examiner.

c. Comparison with nearby protected areas. (Fig. 45.)

In considering height, it is well to remember that height growth of forage plants in general is often much reduced at the frontiers of their zones of occurrence, owing to unfavorable site conditions.

2. Too-close grazing of main forage species

3. Close grazing of secondary feeds growing in mixtures -- In the matter of appetite, grazing animals are much like people -- given a choice between "hardtack" and "fried chicken" they eat the chicken. Palatability means more than nutritive content. Various bunchgrasses, for example mountain bunchgrass and pine bunchgrass, are "hardtack," and when found in mixed types are commonly not utilized until more palatable plants have been closely eaten. Therefore, when "hardtack" is found closely eaten, the better-liked plants usually have been injured.

Another example of this is bear-grass (Nolina microcarpa) which during the recent drouths was grazed down to a basal tuft, over large areas in the Southwest. Ordinarily this plant is but lightly grazed and, with the exception of new shoots, buds, and blossoms, is often ignored by stock. When stock are forced to graze it closely, it is safe to assume that other more palatable forage plants have been decidedly damaged. (Fig. 20.)

4. Thinning grass sod and dead branches of shrubs (Fig. 21.) -- Protected areas which are never grazed show a small amount of dead grass intermixed with the green, but even a small amount of experience enables an examiner easily to distinguish this natural condition from the unnatural where tufts and bunches begin to disintegrate.

On ranges where palatable browse forms an important part of the forage, continued close grazing tends to thicken the individual bushes, giving them an ornamental-shrub appearance. When the danger point in intensity of use is crossed, the vegetative damage shows up in two forms which generally can be recognized:

a. Twigs eaten back farther than one year's growth, the branches becoming "stubby."

b. Numerous branches, and occasional entire bushes, dying.

5. Replacement of climax or original types of plants by weeds or less desirable species -- Such replacement always means lessened production of valuable forage. An example would be a blue-grama range where "six-weeks grasses," annual weeds, or inferior shrubs are actually encroaching upon areas originally dominated (you believe) by blue grama. The difficulty lies in the phrase "actually encroaching." The mere presence of such undesirable plants does not show in which direction range productivity is now headed. In fact, areas of such plants are common on ranges misused in the past but actually improving at the present time. Such plants usually retain their foothold long after the original cause of their invasion has been removed. To aid in a correct "reading of the signs" as they relate to such inferior species, it must be remembered that:

a. An abundance of young plants (especially current year's seedlings) as compared to mature plants, coupled with other signs of range deterioration such as a lack of vigor or actual thinning of good forage plants, indicates invasion actually occurring.

b. A relative scarcity or absence of young plants and a vigorous stand of the good forage species indicates that any former invasion of these weeds has halted.

6. Erosion -- Fundamentally, so much remains to be determined about this subject that its use as a range indicator is full of chances for error. Any attempt to correlate present erosion with present grazing is especially

difficult. Three generalizations apply particularly to this paragraph:

a. Any serious erosion over a grazing area reduces its productive value now and for the future.

b. Distinct increase in number of recent gullies certainly indicates a "slipping range" and is, of course, very often one of the later stages of overgrazing, but may be due to other causes.

c. Failure of vegetation to reclaim very small gullies resulting from past abuse also indicates that recuperation has not yet begun.

7. Condition of stock -- Poor condition of stock, often associated with ranges on the decline, has distinct limitations as an indicator of heaviness of grazing. The examiner must know the history of the season's use, condition of the animals when entering the range, and various other facts before he can form much of a conclusion. At best, it is a tricky factor to depend upon.

Damage to timber reproduction

This problem must be given careful consideration in all inspections of forest ranges. Various studies of this problem have been made, more particularly in its relation to western yellow pine and aspen. The reference publications listed should be reviewed by all Forest Officers. Brief and general comments as to their content include:

1. Western yellow pine[1/] -- Serious damage on overgrazed areas. Slight injury by cattle on moderately grazed areas, negligible damage by cattle on lightly grazed areas. Damage by sheep under any grazing system; seriousness of damage dependent upon many factors. Palatability and sufficiency of forage are important factors; for example, much less damage where forage is ample and largely grama or succulent herbs than on areas where coarse inferior bunchgrasses predominate. Season of use another

---

1/ Hill, R. R.
EFFECTS OF GRAZING UPON WESTERN YELLOW-PINE REPRODUCTION IN THE NATIONAL FORESTS OF ARIZONA AND NEW MEXICO
U. S. Dept. Agr. Bul. 580, 27 p., illus. 1917

Sparhawk, W. N.
EFFECT OF GRAZING UPON WESTERN YELLOW-PINE REPRODUCTION IN CENTRAL IDAHO
U. S. Dept. Agr. Bul. 738, 31 p., illus. 1918

Pearson, G. A.
NATURAL REPRODUCTION OF WESTERN YELLOW PINE IN THE SOUTHWEST
U. S. Dept. Agr. Bul. 1105, 144 p., illus. 1923

important point. Exclusion necessary in certain cases.

2. Spruce and fir -- Serious injury on overgrazed areas. Southwestern studies similar to those conducted on western yellow pine needed to establish final conclusions for the various phases of the problem.

3. Aspen[1/] -- Studies farther north showed: severe damage by sheep; some damage by cattle, but usually slight except under congestion or overgrazing. Again, more investigations desirable under southwestern conditions.

4. Juniper and pinon -- Negligible damage in Arizona and New Mexico except on overgrazed localized spots. Stock more likely aids general establishment of reproduction, at least of juniper.

Two cautions: First, that absence of satisfactory reproduction is not a reliable index of overgrazing; other possible causes, or at least contributing factors, include fire, inadequate number of seed trees, and unfavorable site conditions. Second, that insects, particularly tip moth, often result in a distorted stunted appearance of yellow-pine seedlings, very similar to sheep damage. Care should be taken to distinguish between these two types of injury. (Figs. 41 and 42.)

Causes of range decline

Range deterioration may be either rapid or slow; may be due to past or present abuse, preventable or unavoidable. Specifically in the Southwest it usually results from any one or a combination of the following principal causes:

1. Overgrazing (Figs. 24 and 25.)

Not necessarily too many animals; often the wrong class of stock or, more likely, poor handling and distribution, or an improper season.

2. Roads, trails, railroad grades, and irrigation ditches (Fig. 37.)

These works of man have been primarily responsible for much destructive soil washing. Formerly in the range country many grassy swales and valleys of low gradient were traveled occasionally by wagon. Some of these travel routes continued to be used as roads; others were abandoned; in either event soil washing was invited. The breaking of sod for modern road grades, and their drainage systems to keep the water off of the highway grade, have been the direct cause of much soil erosion.

1/ Sampson, A. W.
EFFECT OF GRAZING UPON ASPEN REPRODUCTION
U. S. Dept. Agr. Bul. 741, 29 p., illus. 1919

3. Cultivation

Plowing of original forage sod in many valleys and swales and occasionally on slopes of dangerous steepness has been a powerful agent in starting erosion, which has continued far beyond the confines of the area originally cultivated. This is especially true of fields cultivated for a time and then abandoned, in which cases forage production has also been reduced.

4. Drouth

The Jornado Range Reserve results show that ungrazed sod of woolly-foot grama (Bouteloua eriopoda), also called black grama, was reduced in density almost 50 percent owing to drouth alone during the past few years. The quadrats on the Tonto Forest show a reduction of curly-mesquite sod, from the same cause but in lesser amount -- not exceeding 10 to 15 percent on the small areas studied.

5. Range-destroying rodents

Prairie dogs in particular cause tremendous damage, often over large areas. Various other rodents such as kangaroo rats, mice, and gophers have caused range injury variable in character and intensity, but the exact role of each species remains to be worked out. (Fig. 39.)

6. Logging operations, especially skidways

The breaking of the vegetative cover by skidways and wheel roads and the excessive travel of logging teams up drainage lines invite erosion. (Fig. 38.) In addition, carrying capacity is often materially reduced through the covering and killing of vegetation by slash.

7. Fire

Destructive fires temporarily remove the bulk of the vegetative bar to soil washing. Washing of soil follows, especially if heavy rains fall before vegetation returns. (Fig. 40.)

8. Floods due to natural causes

How much range damage is due to "natural" floods and how much to those caused or aggravated by man-made conditions have never been determined. There have always been occasional floods caused by sudden violent storms, long continued general and heavy rainfalls, or heavy rainfalls on frozen ground -- conditions in no way connected with man's activities.

9. Chemicals in the soil

Small denuded areas supporting little or no vegetation may not indicat range abuse, but rather a heavy soil content of gypsum or other chemicals unfavorable to plant growth. (Fig. 36.)

Earmarks of past range abuse

1. Disappearance of formerly abundant forage plants

This point is tricky, for in order to draw correct conclusions one must know what the type of country should grow. Moreover, this "earmark" refers to a condition which, to anyone not familiar with the specific type of range, would not be recognized as overgrazing. There are examples where such areas have been reported as excess-feed areas! For instance, there exist plant associations in which certain very palatable plants formerly comprised from 20 to 40 percent of the feed, the remainder being made up of less-liked and less-valuable bunchgrasses. Through continued heavy grazing, the very palatable plants were either killed or kept so closely nipped as to be hardly noticeable, whereas the bunchgrasses were not eaten in marked degree. To a casual observer the unused bunchgrass would indicate surplus range. The continuation of this process results in time in the practical disappearance of the minor, but nevertheless very important species. Aids to the recognition of this condition include:

a. Occurrence of surviving bunches of grass on small "hummocks," the lower surrounding soil being either bare or covered with inferior plants.

b. Statements of reliable pioneers, or other records, relative to the former vegetation.

c. Comparison with local areas ungrazed for years.

It is dangerous to attempt to justify local killing out of inferior bunchgrasses by the assumption or hope that "something better will come in." True, such replacement has occurred in certain localities in which conditions are very favorable, for example areas above 8,000 feet, and especially on the Carson, Santa Fe, and Lincoln National Forests, where Kentucky bluegrass (Poa pratensis) has spread and is still spreading, in drainage lines and over slopes formerly mantled with bunchgrass. In these exceptional cases an introduced species has proved to be more desirable than the native.

It should be remembered, however, that the killing out of admittedly secondary plants such as mountain bunchgrass or pine bunchgrass is usually followed by a growth of still less desirable plants. Where the hope is voiced that blue grama may replace these two bunchgrasses, it must also be remembered that blue grama spreads very slowly. On the Coconino, areas weakened by former overgrazing are still improving after ten years' protection. There is no greater fallacy prevalent in the range country than the remark that "one good seed year will bring back an overgrazed range."

2. Suspicious abundance of certain plants

Most of the native plants in the following list originally were

found in small percentages on ranges that were never overgrazed; nevertheless, their presence in abundance (often locally dominating the stand) on any range is a logical reason for suspecting bad handling in the past. Some of the more common of these so-called "plant indicators of disturbance" are:

Snakeweed . . . . . (Gutierrezia)
Rabbitbrush . . . . . (Chrysothamnus)
Senecio (or butterweed) . . . . (Senecio)
Horehound . . . . . (Marrubium)
Russian-thistle . . . . . (Salsola pestifer)
Prickly poppy . . . . . (Argemone)
Silvery nightshade . . . . . (Solanum)
Dwarf bush daisy . . . . . (Leucelene arenosa)
Ragweed . . . . . (Gaertneria or Ambrosia)
Knotweed (or barnyard weed) . . (Polygonum)
"Six-weeks grasses," including (Bouteloua prostrata, Sporobolus confusus, and Munroa squarrosa)

Annual grasses and weeds may occur locally in great abundance and still not indicate any abnormal condition. For example, over many true desert ranges in southern Arizona the rainfall is inadequate in amount or distribution to maintain a sod of perennial grasses through the many weeks of high summer temperatures. Here, a heavy growth of "six-weeks' feed" has perhaps always followed favorable winter rains.

Thus, again is emphasized the need for "knowing the vegetation." Russian-thistle is an example of an aggressive introduced weed that has invaded vast areas of range and farm land since its arrival from Russia in 1873 or 1874. Many introduced plants are true weed pests, others are valuable forage plants, for example "filaree" (Erodium cicutarium) and Kentucky bluëgrass. Others may be discovered.

3. Serious erosion and denudation

Widespread erosion, or denudation when not explained by some condition beyond man's control, may be taken to indicate destructive range mistreatment in the past.

HOW TO GET MORE UNIFORM RANGE JUDGING INTO ACTUAL PRACTICE

Five suggestions are offered:

1. Continued explanation and discussion of practical range judging hints by the Office of Grazing

The tremendous advantage of personal explanation on the range, as against any known correspondence method, cannot be too strongly stressed in getting results.

2. Frequent comparisons with protected areas or fenced plots

On the Tonto National Forest where plots are less than four years old, attention must for a time largely be limited to practical comparisons. On the Coconino, where ten years' results are now available, all local officers should visit the five plots and note what has happened in order to explain the results better to visiting officers, stockmen, and other interested parties such as County Agents. Whenever opportunities occur, these plots should be pointed out to stockmen, emphasizing their practical uses and mentioning the high points of experimental results to date. Progressive stockmen will be found greatly interested.

3. Construction of more protected comparative areas

Small check plots, not for scientific study but for practical comparisons, are badly needed on every Ranger District in District 3. One representing a fair sample of each broad kind of range should be provided just as quickly as administrative funds and time permit. "Broad kinds of range" implies large divisions such as grama, bunchgrass, or mixed grass-woods -- areas requiring different handling. The most feasible kind of fencing may be used, for example pole fences on the high-altitude ranges.

4. A working knowledge of important range plants

Range judges must know the vegetation they are judging -- common names, growth requirements, and forage values of important range plants and forage types.

5. Recording of more definite observations

In order that the changes through the years may be followed more closely and with less chance of serious error because of the frailty of memory, the recording of more observations by field men than has been done in the past is necessary. Ten years from now even a brief word-picture of conditions on any allotment in 1923 will be of great service to administrators trying at that time to correct some mistakes that may not be realized now.

A graphic supplement follows.

PICTURES, NOT PARAGRAPHS, TELL THE STORY BEST

Figure 1. - A Level or Undulating Short-Grass Range

Other things being equal, ranges with this kind of topography (where slopes are very gentle and drainage lines are shallow wide-bottomed valleys) withstand the heaviest grazing use with least danger of erosion.

Figure 2. - A Level or Undulating Bunchgrass Range in the Yellow-Pine Zone

From a vegetative standpoint, ranges of this kind cannot be safely grazed to the same closeness as can short-grass ones, for two reasons:

(1) Bunchgrass is killed more easily than sod grasses such as blue grama.

(2) Close grazing of this less-liked class of feed is apt to result in unwarranted injury to young pines. The risk is greater with sheep than with cattle.

Figure 3. - Rolling Range

When slopes are steeper, run-off waters attain higher velocities and have far greater erosive power; hence, more vegetative protection (lighter grazing) is necessary than on more level areas, in order to hold erosion to the practical minimum.

Figure 4. - Rough Rugged Grazing Grounds

From the standpoint of topography alone, ranges of the character shown in the background must be grazed the lightest of all if the forage carpet is to be maintained at maximum productivity and dangerous erosion prevented.

Figure 5. - A Meadow or "Cienaga"

These localized areas of deep damp soil produce a greater volume of forage than the adjoining drier slopes and ridges.

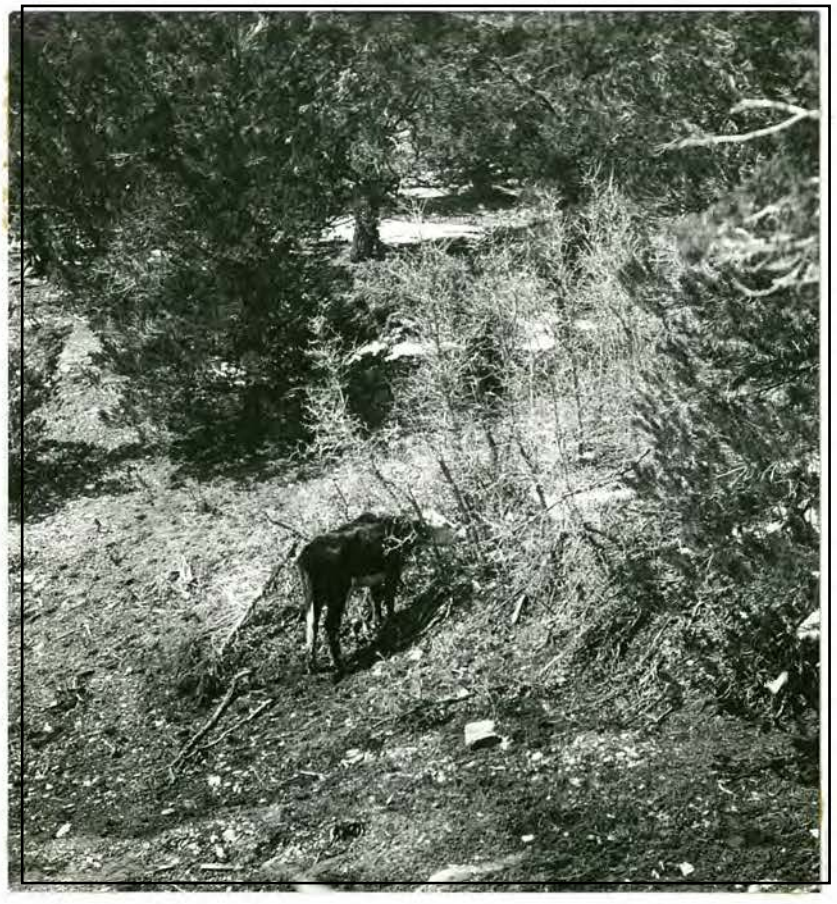

Figure 6. - Too-early Grazing of a Mountain Range

If grazing animals are allowed to follow the receding snows too closely, when the new forage growth is still scant and "washy," both the range and the animals suffer.

Figure 7. - Judging Utilization of Alternate Strips of Grass and Brush

On some ranges heavy stands of brush are found on northern exposures, open grasslands on southern. If grazing heavy enough to hold down the brush means decided damage to the grass, range conditions should be judged by the grass. Such a range is illustrated above. More uniform use of forage can often be obtained by salting in the lightly grazed areas.

Figure 8. - A Very Dense Mixed-Browse Range

The brush in this locality is rapidly growing beyond the reach of grazing animals. Regardless of this fact, grazing sufficiently heavy to insure stunting the bushes and opening up the stand, in order to delay the date when stock will be crowded out, is rarely justified in this kind of country for two reasons:

(1) Destructive erosion would very likely occur in watersheds of this steepness.

(2) Young timber reproduction (which is gradually invading the browse type) would certainly be damaged.

Figure 9. - Is This Excess Range?

Yes,

(a) If found in this condition toward the end of the grazing season,

(b) If the condition pictured is general over the grazing area, and

(c) If obtainable control and handling of stock permit closer use of the forage crop without damage to young timber in the background or excessive soil washing.

(It happens that this photograph was taken on a northern exposure on a range whose south slopes were very closely utilized grama types; consequently on this range the comparatively inferior bunchgrass was not excess feed.)

Figure 10. - Nonpalatable or Inferior Plants Are Inaccurate Indexes of Excess Range

This happens to be sleepy grass (Stipa vaseyi) growing untouched by stock on an overgrazed range.

Figure 11. - This Ungrazed Grass Is Not Excess Range

The almost untouched patches are tobosa-grass. The closely grazed grass is black grama. The season was well advanced when this photograph was taken, and a stocking heavy enough to force cattle to eat these small islands of tobosa would have destructively damaged the grama which is of far greater importance.

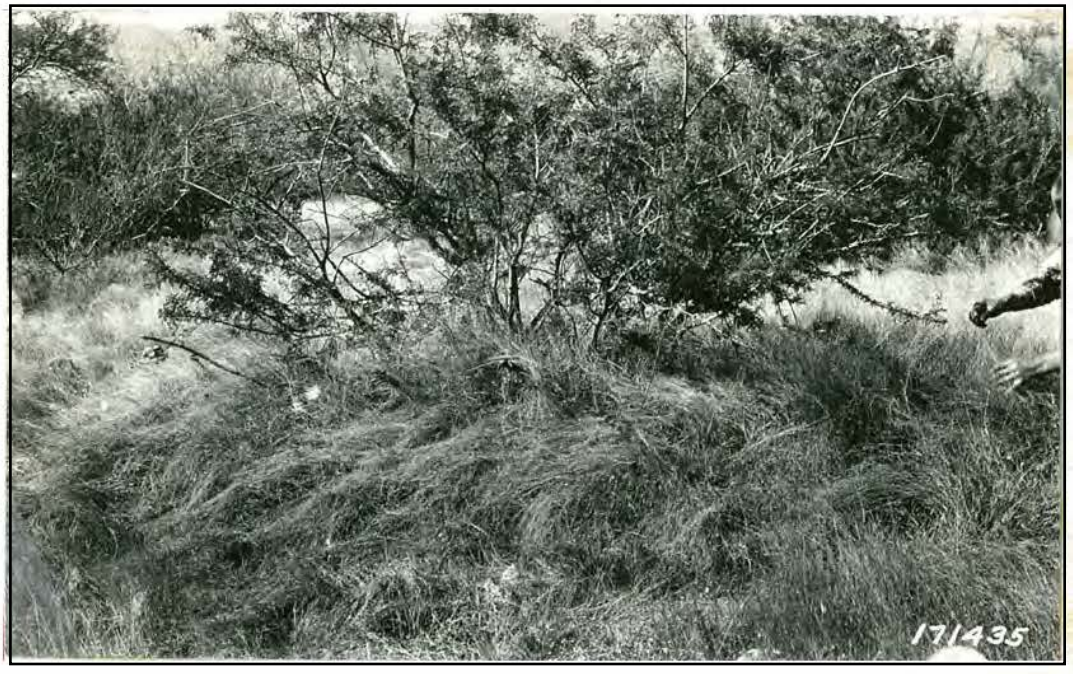

Figure 12. - Very Heavy Growth of "Six-Weeks' Feed"

This shows occasional conditions on desert ranges, usually in early spring. More livestock can be accommodated for short periods on such areas provided the animals can be promptly removed from the area when these short-lived crops dry up and disappear.

Figure 13. - The Scarcity of "Six-Weeks' Feed" During a Dry Year

This photograph was taken at a different time on the same area shown in the preceding picture and shows the scarcity of annual forage plants during drouth years, and also during dry periods of every year. This illustrates the fallacy of placing much dependence upon these temporary and uncertain forage crops.

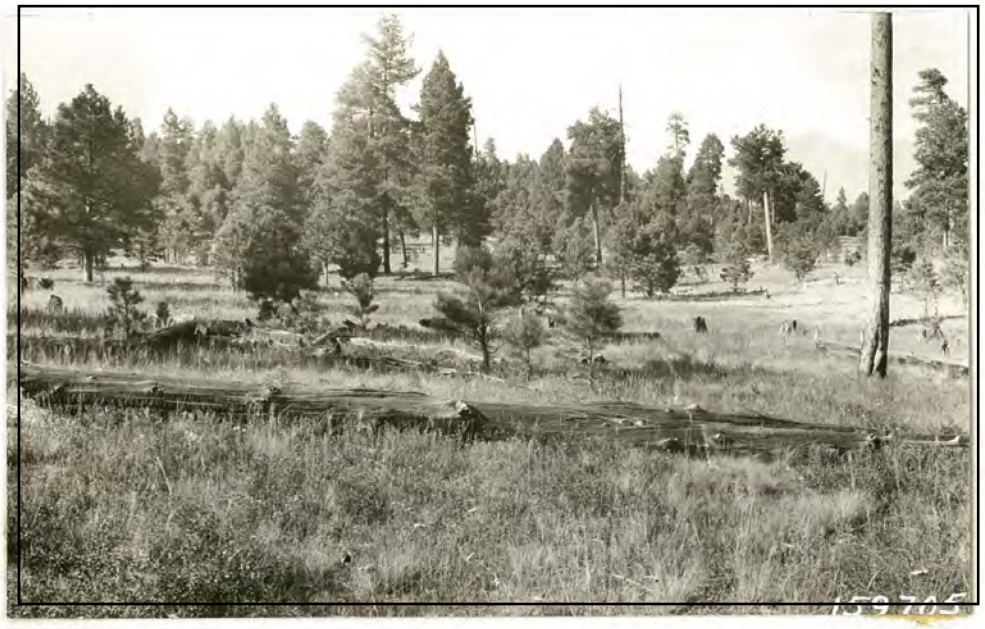

Figure 14. - A "Bunchgrass, Mixed-Grass-Weed" Range in Satisfactory Mid-Season Condition

(1) Plenty of feed remains in the middle of the grazing season to last until its close and still leave a small surplus.

(2) Erosion is negligible.

(3) Valuable perennial plants predominate.

(4) Young pines within reach of stock show only negligible injury.

(5) The density of vegetation is about as high as the climatic and soil conditions of the region will permit.

Figure 15. - A Properly Utilized Summer Range at the End of the Grazing Season

Figure 16. - A Fully Used Range

The palatable plants have been grazed closely. The conspicuous plants are of low value and should be ignored in judging the degree of utilization.

Figure 17. - One Cause of Past Overgrazing of Mountain Ranges

During most of the year cattle tend to drift to the open parks. Sheep are more easily herded when in sight. Consequently, open parks and mountain meadows, especially those near water, are usually abused more than the remainder of the range. Close supervision and insistence on progressive handling are the obvious remedies.

Figure 18. - The Replacement of Vegetative Type as an Indicator

Retrogression of the right-hand range is here clearly indicated by:

(1) Palatable chamizo brush (Atriplex canescens) in abundance in the protected pasture to the left, but absent in the one to the right.

(2) Invasion of inferior rabbitbrush (large dark plants) and snakeweed (smaller plants in between) coincident with a thinning of grama sod.

The main cause of the change in type is overgrazing. Contributing causes are more obscure, but include drouth.

Figure 19. - Close Use of Inferior Plants Is Usually a Reliable Index of Overgrazing

These two plants are Spanish dagger (or bayonet) (Yucca baccata) and bear-grass. When these are eaten down over the range as a whole, serious injury has already occurred to the principal feed plants -- in this case blue grama.

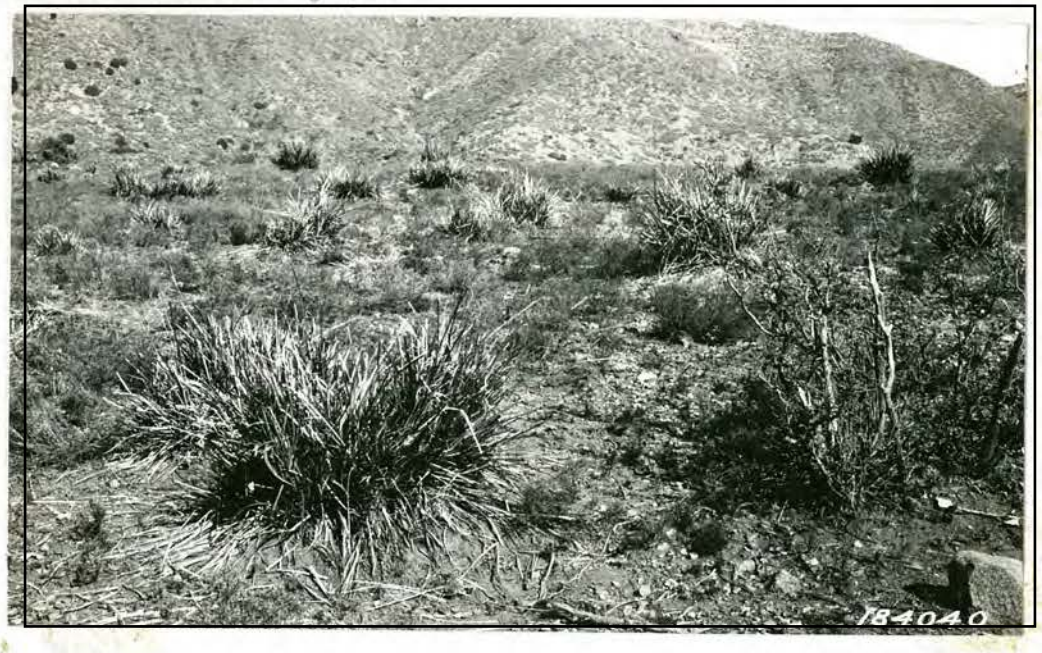

Figure 20. - Seriously Overgrazed Range at 5,000 Feet Elevation

(1) ~~Bouteloua~~ (A) is heavily browsed.

(2) Catclaw bushes (~~to the right~~ B) are almost killed. The original hairy grama (Bouteloua hirsuta) and curly mesquite grasses have been thinned and in their place snakeweed is coming in.

Sacahuista (Beargrass)

Figure 21. - Unmistakable "Disturbance Indicators"

(1) Increasing erosion; roots of bushes and grasses partly exposed.

(2) Thinning of grama sod.

(3) Intensive browsing of oak bushes to the point of stubby appearance or even the killing of occasional plants.

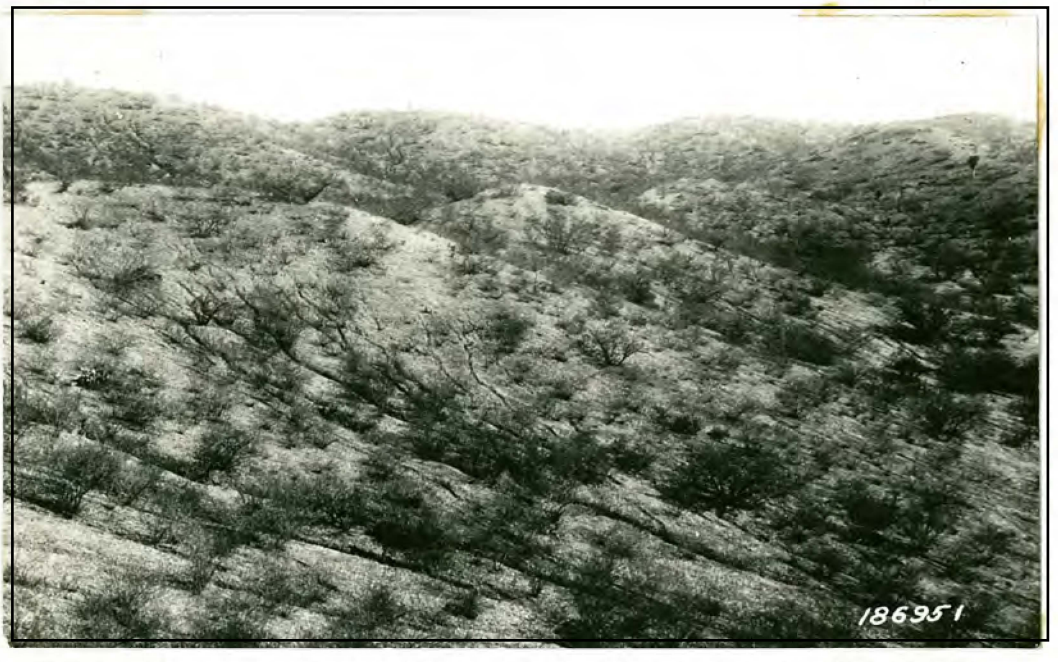

Figure 22. - Unmistakable Earmarks of a Deteriorating Range

It is not known whether all of the erosion shown in the picture is due to overgrazing (see text for other causes). It is clear, however, that unless the causes are quickly removed, permanent injury will spread over the entire area.

Figure 23. - A ~~Seriously Overgrazed~~ Damaged Area in the High Summer Ranges

Unmistakable earmarks of overgrazing:

(1) Grazing down to dead stubs and often killing of the willows.

(2) Disappearance of easily killed-out valuable forage plants, leaving the more resistant bunchgrasses on hummocks.

More doubtful earmarks:
(Overgrazing is frequently the most important factor but various others must be considered.)

(1) The absence, scarcity, or deformed appearance of timber seedlings.

(2) The beginning of bad erosion.

Usual causes of such unsatisfactory grazing conditions:

(1) Too many animals for the available feed during the available season.

(2) Grazing too early in the spring.

(3) Poor distribution of stock resulting in heavy concentrations in open accessible parks near water.

(4) Uneven utilization resulting in wasted feed over some portions of the range.

If (1) and (2) do not apply, then (3) and (4) may be remedied in the case of cattle by better riding, salting and water development; and solved in the case of sheep by adequate distribution, open herding and one-night camps.

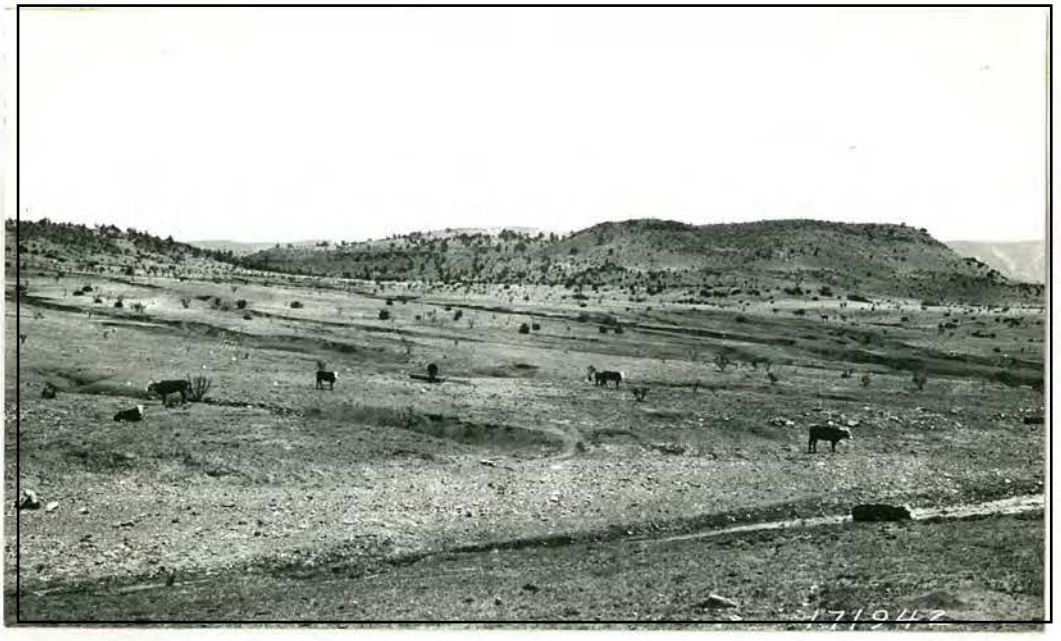

Figure 24. - A Destructively Overgrazed Range in the Woodland Type

This picture taken near water where too much stock has congregated for years has resulted in:

(1) A general thinning of the sod for one-half mile back from water.

(2) Disappearance of valuable forage plants near water.

(3) An increase -- at first slow, but during recent years rapid -- of both gully and sheet erosion.

Figure 25. - A Stage of Range Destruction Recognized by Everyone

Many of the various contributing causes of erosion listed in the text may have aided in the sad state of affairs above pictured, but the evidence against grazing as the prime cause is here conclusive. The "contour" stock trails are sometimes spoken of as "terrace erosion" and the whole condition might be referred to as "horizontal and vertical erosion." This is an example of destructive overgrazing, which on the steep slopes has destroyed the protective and productive value of all perennial vegetation. Many soils occur as thin layers overlying solid bedrock near the surface. Once erosion due to any cause has removed this thin veneer, the ruin is complete and permanent.

Figure 26. - Seriousness of Range Erosion Varies with Class of Soil

Though difficult to estimate the economic loss in deep-soiled valleys like the above, some of which can be cultivated, it is nevertheless true that it is often possible, though costly, to reclaim arroyos which have reached this advanced stage.

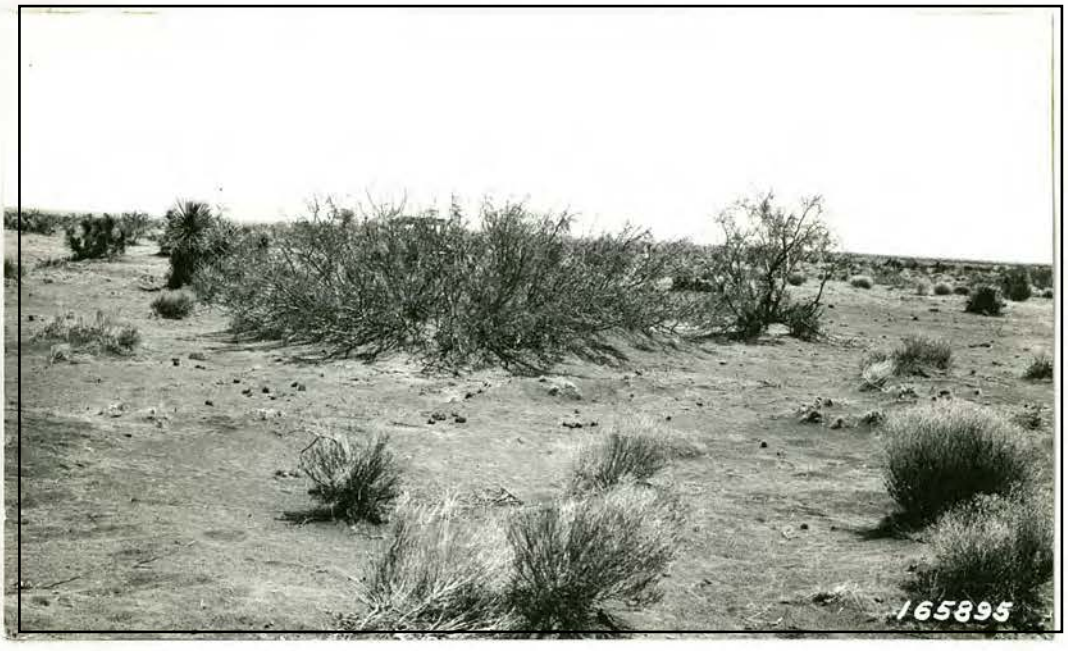

Figure 27. - The Beginning of the Last Stage of Destructive Overgrazing on Sandy Soil

When the original covering of perennial vegetation is sufficiently weakened, wind erosion may reduce the range to sand dunes.

Figure 28. - Starving Cattle Subsisting on Cottonwood Twigs and Leaves During the 1923 Drouth in New Mexico

When feed scarcity near water reaches such a desperate stage as this and heavy losses of cattle are occurring, it is safe to assume that the back-lying ranges have already been badly damaged by overgrazing.

Figure 29. - Feed Shortage Increases the Danger of Losses from Poisonous Plants

Figure 30. - First Signs of a Range "on the Mend" Where Former Grama and Curly Mesquite Sod Has Largely Disappeared Through Continued Overgrazing

Following the establishment of proper grazing, grasses slowly reappeared in the bottoms of these gullies.

Figure 31. - A Valuable Gully-Prevention Plant Within Its Range

Vine grass (Panicum obtusum) spreads rapidly over many ranges within the woodland type where moisture conditions are best. It aids in anchoring soil in small rocky gullies.

Figure 32. - Proof of an Improving Range

Blue grama has here taken possession of former deeply-cut stock trails. The vegetative carpet spread over the formerly denuded areas is Nature's check against erosion.

Figure 33. - What May Plant Indicators Indicate?

Figure 34. - Plow Indicators, Not Cow Indicators.

This old abandoned field, cultivated a number of years ago, no longer shows the furrows of the plow but does show very thin sod (where the original grasses are so very slowly returning) and a heavy stand of snakeweed which also occurs on the adjoining range, but in smaller amounts.

Figure 35. - Plant Indicators of Disturbance

The senecio shown growing thickly in this stump circle is often taken as an overgrazing indicator. The term "disturbance indicator" is much to be preferred. In this case, for example, the "disturbing" factor was the cutting of the tree rather than excessive grazing. This same principle applies in the use of all plant indicators and shows the need for careful scrutiny as to "what they indicate."

Figure 36. - Denudation Is Not Always Due to Grazing

Locally in the Southwest, the soil content runs high in mineral salts which in large amounts are detrimental to the growth of most forage plants. Grazing is a very minor factor in this barren condition.

Figure 37. - Gullies Often Follow Roads

How much erosion is due to roads and how much to grazing is in many places difficult to judge. The fact remains, however, that roads have been a powerful aid in the beginning of destructive erosion in many drainage lines.

The concentration of flood waters through culverts under road grades, trails, and irrigation ditches is often a direct cause of the beginning of bad gullies.

Figure 38. - Logging Is Another Big Contributing Cause of Soil Washing on Certain Ranges and of Reduction in Their Grazing Capacity

Logging camps placed in deep-soiled valleys and canyons, wheel roads extended up all drainage lines which can be traveled, and skid-ways at frequent intervals along slopes, destroy or weaken the vegetative protection against erosion. As with fires, the extent of the danger depends in large degree on whether heavy washing rains follow "on the heels" of logging.

The reduction in carrying capacity resulting from these operations and the covering of forage by slash must be recognized and the number of grazing animals adjusted accordingly; otherwise further danger will follow.

Figure 39. - An Old Dog Town

Prairie dogs both consume the forage and kill the sod. Over many areas they are more active agents of range destruction than any other one cause.

Figure 40. - Serious Erosion May Follow Forest Fires

When intense fires destroy all ground cover, the stage is set for heavy soil washing if dashing rains occur before new vegetation can again cover the soil. Grazing of fresh "burns" should be supervised with especial care.

Figure 41. - Yellow-Pine Seedling Seriously Injured by Sheep

Figure 42. - Yellow-Pine Seedling Injured by Tip Moth

Stunted distorted yellow-pine seedlings do not always indicate injury from grazing animals. The tip-moth injury here shown occurred on a fenced plot where all grazing had been excluded for years. Tip-moth injury is seldom so severe, but the need for close observation is evident.

Figure 43. - Flood-Control Current Deflector

Figure 44. - Another Type of Current Deflector

Destructive floods that carry immense quantities of eroded material necessitate costly engineering structures. We know that erosion has greatly increased in recent years and that overgrazing and drought have been two big causes.

Figure 45. - A Range Study Plot on the Tonto National Forest

Fenced areas of this kind are employed for the scientific study of any vegetative changes which may be going on, especially the very slow ones that are difficult to follow from year to year by observation alone.

Areas fenced against grazing provide practical aids to the judging of range utilization.

(1) The plot shows what the range would look like if ungrazed.

(2) The plants that make up the bulk of the feed are more clearly picked out.

(3) Grazing does not obscure the size of the current year's crop.

(4) By comparison within and without the fence a close estimate of adequacy of range feed for the remainder of the grazing season is made possible.

(5) If the plots are large enough, comparison of erosion within and without the fence can be made.

(6) A more accurate analysis of the causes of mortality among timber seedlings can be made by eliminating the grazing factor.

Figure 46. - A Quadrat

Small squares on the ground are permanently located by stakes, and plant maps made at intervals varying from 6 months to 3 years, in order to record any vegetative changes.

Figure 47. - Areas Already Available Should Be Utilized as Far as Possible to Supplement Fenced Plots

Such substitute areas may be:

(1) Pastures or allotments where grazing is deferred or otherwise properly controlled.

(2) Unused administrative-site enclosures.

(3) Railroad rights-of-way.

(4) Cemeteries.

(5) Inaccessible bits of range.

(6) Ungrazed corners of cultivated fields.

(7) Ungrazed corners of Ranger Station yards.